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Optional student use of online lecture resources: resource preferences, performance and lecture attendance

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Abstract

One of the most common uses of a course management system in the on-campus environment is to offer lecture resources to students. Few researchers have investigated how students use such resources. This study considers student use of lecture resources that offer a representation of the lecture presented (i.e. lecture outline, lecture summary, audio recording) and the relationship of the use of such resources to examination performance and attendance. The present research is argued to be an extension of research that investigated the benefits of providing students instructor notes conducted some 30 years ago. The Internet provides a practical way to apply some of these ideas and to collect data on the reaction of students to the opportunity to view lecture resources. Students made very little use of the audio recordings. We suggest audio recordings may be regarded by students as less efficient and less useful than text-based lecture summaries. The use of online lecture resources, lecture attendance, and examination performance were positively related. For one of three examinations, there was a significant negative interaction of note use and attendance in predicting examination performance providing some support for the hypothesis that students may be able to successfully compensate by viewing online lecture resources when unable to attend class. Because students in this study were not asked to explain their use of these resources, the present findings are regarded as speculative. However, given the interests of many practitioners in providing students lecture resources, the descriptive data and the relationships observed here encourage additional investigation.

Keywords absenteeism, course management system, lecture resources, note taking.

Introduction

The typical course management system (CMS) offers instructors a suite of flexible tools. One of the most common ways on-campus instructors use a CMS is to offer students' resources to improve the lecture experience. Morgan's (2003) study of more than 700 university faculty members who used a CMS determined that nearly 70% used the CMS to supplement lectures. The Morgan study failed to move beyond the generation of descriptive statistics on general categories of CMS use and supplementing lectures could mean many different things. Our interest is in supplements that offer students some online representation of the lecture rather than in sources of new information that might expand the material covered in the lecture. Included within our perspective would be the use of a CMS to offer files containing the same presentation software 'slides' that were used in class or audio recordings of the lectures captured with the instructor's laptop computer. The intent in this research is to evaluate student use of lecture representations within the framework provided by a long established research literature evaluating

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and attempting to improve student note taking and note use.

The common practice of making lecture resources available to students through CMSs may reactivate interest in research on student note taking and note use. There are several reasons this existing body of research may gain renewed attention and that additional research will be encouraged. First, it is now far more practical to offer lecture supplements to students. Much of the existing research was conducted at a time when providing a lecture outline to students required making multiple paper copies and bringing these materials to class for distribution. Generating an audio copy of a lecture would have been even more cumbersome. It would probably have been necessary to record the lecture outside of class and then to offer copies of the recording for student checkout at the library or a similar physical location. Now, sharing a PowerPoint presentation through a CMS is quick and inexpensive. Generating a recording in the classroom requires little effort and distribution requires only that the file be uploaded to the CMS. Past and future research on lecture supplements offer information relevant to instructional options now available to most instructors.

Second, student access to digital representations of lecture content allows for the collection of better data on student use of resources in applied settings. Much of the original research on making representations of class presentations available to students was conducted at a time when conducting applied research was difficult and as a consequence the ecological validity of the body of available research was questioned (Locke 1977; Collingwood & Hughes 1978). Much of the research was conducted in laboratory settings with instructional materials atypical of those used in actual classrooms, retention was examined over brief periods of time, and performance was evaluated without authentic consequences to students. Online delivery of content both makes it far more practical for researchers to involve students in authentic learning environments and also makes it possible to more accurately collect data on resource use. When lecture outlines were deposited on a desk in the front of the classroom, members of the class were likely assigned to the lecture outline treatment without knowing for certain that any given student picked up an outline. Online access also allows the collection of data concerning which students download online materials and when these resources are viewed.

Finally, the culture that has developed around online digital media raises new questions that are related to, but extend issues raised in existing research. For example, will voluntary student use of online resources match theoretical assumptions regarding the benefits of providing such resources to students? Will students download lecture summaries before class as would be required to use the summary to guide student note taking? If quality notes and an online recording of classroom presentations are available, will students continue to attend class? These and other questions can be added to the list of issues researchers might now consider.

Brief review of research on providing students lecture notes

Research on student note taking goes back many years and has resulted in a literature that exceeds 100 published studies (Kiewra 1989). A descriptive model proposed by DiVesta and Gray (1972) organized the early research and continues to be referenced by present investigators. This model proposes that students benefit from the process of recording lecture information as personal notes and from the process of reviewing notes. Typically, these interrelated processes are described as encoding and external storage. The process of taking notes is hypothesized to support encoding because of the cognitive activities students must engage to generate a personalized written record of the lecture. The storage function recognizes that student recall of lecture experiences is likely to be incomplete and the written record students generate provides the opportunity to review even those elements of the original lecture that have been forgotten. Because note taking and note reviewing are linked and because many students are unable to generate a well-organized and complete record of the information they encounter, both the encoding and external storage functions can be deficient. Students with poor background relevant to the material presented or with less working memory capacity may simply be overtaxed by the demands of both understanding the information presented and storing a representation of that information (Kiewra & Benton 1988). The inability of students to handle the cognitive demands of encoding and other challenges such as maintaining attention result in a record of lecture content that typically contains less than 50% of the idea units presented (Kiewra 1985). In recognition of the

multiple limitations of students as note takers, researchers began to investigate possible benefits of offering students resources to supplement their own notes. Providing students a quality set of notes potentially both reduces the processing demands that exist during class and assures that a complete record of the lecture exists for review (for a more recent review see Armbruster 2000).

Study overview

This study examines the relationships among voluntary student use of online lecture resources, examination performance, and student attendance. This same set of variables has been examined in a few existing studies (Herson *et al.* 1999; Grabe *et al*. 2004–2005; Grabe & Christopherson 2005; Vandehey *et al*. 2005). Our interest is in the Grabe and Vandehey studies because of the focus on inexperienced students in large enrolment courses and because these researchers offered students lecture resources in multiple formats. The basic structure of the selected studies is very similar. Each offered students two forms of lecture resources – lecture outlines and lecture summaries. Each evaluated student examination performance and student attendance. In the Vandehey *et al*. design, students in different sections of a class either took their own notes, or had access to 'partial' or 'complete' lecture summaries before lectures were given. No group differences in examination performance were observed. Questionnaire data revealed several interpretive difficulties. The authors observed that in the partial note group approximately 70% of students downloaded notes, but 'most' reported they did not look at the notes before the corresponding lectures were given. While the student comments are informative, the data also illustrate an interpretive difficulty with what is typically regarded as the preferred research method for establishing causal relationships. Treatment groups consisted of participants who did and did not actually experience the treatment. The Grabe studies take a more descriptive approach attempting to establish relationships without arguing that the relationships were necessarily causal. The results established positive correlations between note use and performance and between note use and attendance. The Grabe studies are more efforts to investigate individual patterns of note use than to argue that note use determines higher achievement.

The present research can be identified with the approach that attempts to describe patterns of student use of online lecture resources and then determine whether differences in use of these resources can be related to differences in examination performance and class attendance. This research relies on quantitative data collected by the server to document student use of lecture resources. Our non-causal approach is focused more on describing the behaviour of individual students within a naturalistic educational context than on attempting to explain why students would behave as they do or on demonstrating a causal link between the use of a particular lecture resource and performance. The present study is more rigorous than existing research in several ways. Class attendance is measured in an objective manner rather than by relying on participant self-report. Student performance was evaluated by a set of items associated with the specific lectures for which attendance was evaluated and lecture resource use known and attempts to link the use of specific resources, attendance on specific days, and performance on specific examination items. In contrast, previous research interrelated composite variables representing note use, attendance, and examination performance associated with the content covered over many weeks. Our present approach allows for more fine grained analyses. This research also includes audio recordings as an additional representation of lecture content. The intent is to respond to the present interest in providing students online audio of lecture content (e.g. pod-casts – Campbell 2005) and offer some initial descriptive data on the voluntary use of online audio in the context of several alternative sources of lecture information.

Method

Settings and participants

The participants were students enrolled in two Introductory Psychology courses at a moderate sized university. A total of 329 students completed these courses.

Measures

Student attendance and course examinations

The courses were divided into three segments of approximately 5 weeks. During each of the three course segments, students were asked to complete an in-class writing assignment at the end of two class periods as part

of a general education commitment to the development of writing skills. The dates for these writing tasks were unannounced. Completion of a writing task indicated that a student was in class and the number of writing tasks completed was used in creating attendance variables for the semester and within each testing period. The six writing assignments contributed a possible 12 points and represented approximately 5% of the points determining the grade for the lecture portion of the course. Admittedly, awareness of the writing assignments may have influenced lecture attendance.

Each course segment ended with a 50-item, multiple-choice examination covering content presented during lectures and in reading assignments. Twenty-five items on each examination were written by the course instructor to cover topics covered during lecture presentations. Because this research focuses on student ability to process lecture content, student performance on these lecture questions serve as the general measure of achievement. Five of the questions presented on each examination were written to address information presented during the two lectures for which attendance data were collected.

Lecture resources, server data collection, and lecture resource use variables

All lecture resources were made available to students embedded in web pages. Access to all resources required that students first connect to a login page that required a unique identification number and password and that presented a statement required to satisfy the Institutional Review Board policy for informed consent. The student identification number, a page identification code, and the date were written to a log file by the server each time a lecture resource was accessed.

There were three categories of lecture resources; outline notes, complete notes, and lecture audio. The *outline notes* available online were the same lecture outlines displayed using a projector system during class presentations. The outlines consisted of individual web pages containing large text (H1 html tag) that was scrolled as the lecture proceeded. There were approximately two pages of notes for each lecture. Outline notes were available from the server at least 1 day before the corresponding lecture was presented.

A graduate teaching assistant who attended each class generated lecture summaries designated as *complete notes*. The note taker was asked to generate these notes by adding more detailed comments to the lecture outlines. The web page containing the complete notes from each lecture was available before the next class meeting.

The *audio* for each lecture was recorded as the lecture was presented and was made available to students embedded within a web page before the next class meeting. From this page, students could either listen to the audio or download the audio file for storage or transfer to another device.

Data from the server log file were used to generate variables summarizing the proportion of lecture resources accessed during clearly defined time periods. These variables include; (i) *before* – the proportion of resource pages first accessed before the date when the resource was used in class; (ii) *after* – the proportion of resource pages first accessed after the resource was used in class and more than 2 days before the examination; and (iii) *cram* – the proportion of resource pages first accessed within 2 days of the examination. Because audio and complete note resources were not available until after the completion of a lecture, the variable before was not relevant in analysing student use of these resource types.

It is important to note that these variables are based on the date when resources were first accessed and are mutually exclusive. This interdependency must be kept in mind when interpreting results. The variables focus on first access because after first accessing resources online some participants continue using the resources online and others print or store the resources. Across participants, the server can only consistently account for the first access.

Statistical analyses

For the sake of efficiency, statistical analyses reported here as significant imply that $P \leq 0.05$. Mean group differences associated with ANOVA procedures were interpreted using Tukey's HSD statistic (Kirk 1968).

One set of analyses made use of simultaneous multiple regression using centred predictor variables. Regression was used because of the interest in evaluating the interaction of continuous variables (i.e. attendance and amount of resource use). Centring involves subtracting the variable mean from each participant's score and is useful in reducing the risk of multicollinearity. When a significant interaction is present, the regression equation is used to determine the source of the

interaction. Using values for one moderating variable that represent the mean (0), +1 *sd* and −1 *sd* of that centred variable, unstandardized beta weights for the variables are entered into the regression equation to generate regression lines. These lines are graphed to explain the interaction (Cohen *et al*. 2003).

Results

Student use of online lecture resources

Participants who completed the course accessed an average of 61% of the available outline notes ($sd = 0.31$), 19% of the complete notes ($sd = 0.26$), and 3% of the audio resources ($sd = 0.07$). Additional analyses investigating sources of variability associated with resource use are presented in the following sections. Because of the low use of audio resources, no further analyses were conducted with audio resource data.

Absenteeism and use of online resources

On average, participants attended 4.31 of the six classes during which attendance was recorded ($sd = 1.8$). It was assumed that attendance during these six class periods was representative of typical rates of attendance during the rest of the semester. Extreme groups were identified in order to search for possible relationships between attendance and use of online resources. Attendance values were selected to satisfy the goal of creating groups most identical in size. The *high attendance* group represented 37% of the participants and attended all six classes. The *low attendance* group represented 28% of the sample and attended three or fewer classes. The authors have decided to report findings based on extreme groups to demonstrate that differences in note use can be associated with differences in attendance and to limit the complexity in describing the results of these analyses. An ANOVA using all participants divided into three groups produced a very similar pattern of results with the middle attendance group generating means more aligned with the high attendance group.

Outline note use data were analysed using a 2 (Group – Low attendance, High attendance) × 3 (Examination – First, Second, Third) × 3 (First Access – Before, After, Cram) mixed design ANOVA. Examination and First Access were repeated measure variables. Complete note use data were analysed using a similar model with the elimination of Before from the First Access factor (After and Cram remain). These are complex designs and the analyses produced many significant main effects and interactions. To simplify our description, the complete ANOVA summary tables have been included (Table 1) and all means are displayed in Fig 1.

Table 1. Analysis of variance for outline note access.

Source	d.f.	*F*	Partial Eta squared
Group (G)	1	24.25*	0.10
Error (G)	210	(2.23)	
Examination (E)	2	19.63*	0.09
G × E	2	0.49	0.00
Error (E)	420	(0.030)	
First Access (FA)	2	49.16*	0.19
G × FA	2	32.50*	0.13
Error (FA)	420	(0.136)	
E × FA	4	9.78*	0.04
G × E × FA	4	3.83*	0.02
Error (E × FA)	840	(0.051)	

Note: Significant outcomes marked with an asterisk (*). Values in parentheses represent mean square errors.

Outline notes

Those who attended class on a more regular basis also made greater use of outline notes, $F_{1,210} = 24.25$. Means for the high and low attendance groups were 0.075 ($sd = 0.034$) and 0.052 ($sd = 0.033$) respectively. In interpreting these means it is important to remember that the ANOVA model divides up first access into multiple categories and the total proportion of notes accessed would be nine times these means.

Both within main effects were significant; First Access, $F_{2,420} = 6.70$, and Examination, $F_{2,420} = 19.63$. Students were most likely to use outline notes before attending the corresponding lectures. *Post hoc* comparisons indicated that the First Access means were significantly different (Before > After > Cram). Use of Outline notes dropped across examinations and *post hoc* comparisons indicated that access associated with the third examination was significantly less than for the first two examinations. These two factors also generated a significant interaction, $F_{4,840} = 9.78$. Across examinations, access to notes before the lectures was significantly lower for the third examination (First = Second > Third) and note access categorized as

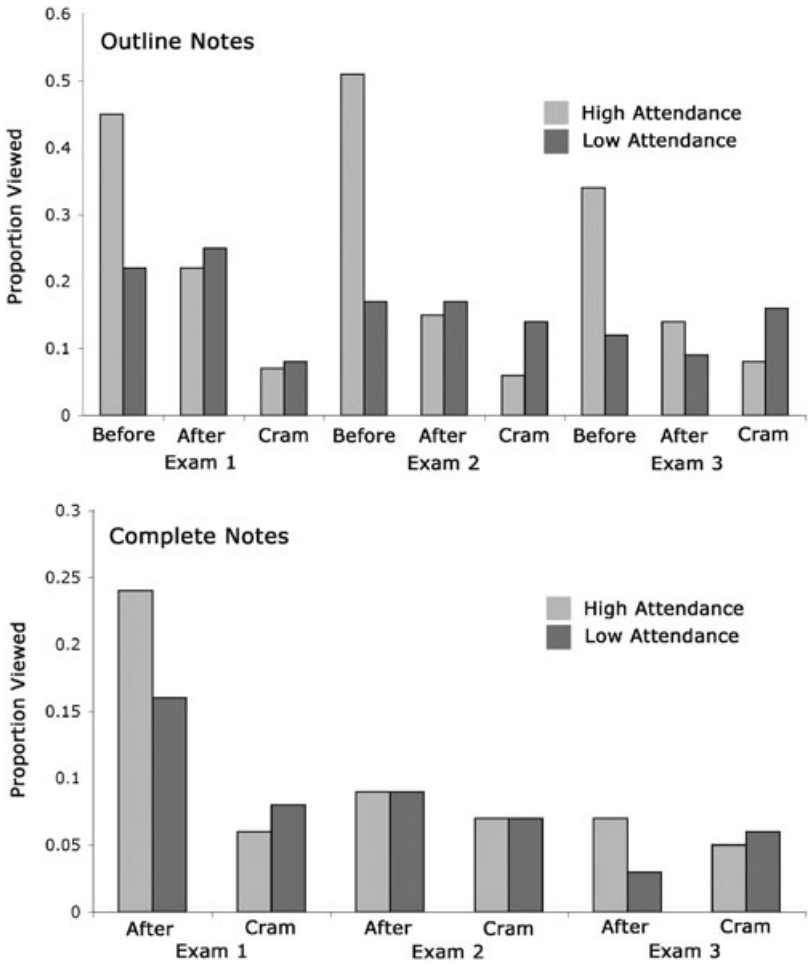

Fig 1 Mean proportion of outline and complete notes accessed as a function of attendance group, examination and first access.

After dropped significantly for the second and third examinations (First > Second = Third).

Two significant interactions involved Attendance Group; Attendance Group × First Access, $F_{2,420} = 32.50$, and Attendance Group × First Access × Examination, $F_{4,840} = 3.83$. *Post hoc* analyses of the Attendance Group × First Access interaction indicated that groups differed only in their access to notes before lectures. The three-way interaction indicated that use of notes before lectures differed across groups for the first and second, but not the third examination.

Complete notes

The analysis of participant use of Complete Notes generated main effects for Examination, $F_{2,420} = 24.33$, and First Access, $F_{1,210} = 8.35$. Use of Complete Notes declined systematically across examinations (Exam 1 > Exam 2 > Exam 3) and participants made greater use of notes immediately after lectures were given than during the 2 days before examinations (After > Cram).

The analysis revealed one significant interaction; Examination × First Access, $F_{2,420} = 15.33$. *Post hoc* analyses indicated that a difference in the proportion of notes viewed during After and Cram was evident only for the first examination (Table 2).

Use of online resources, absenteeism and examination performance

Multiple regression analyses were used to determine the extent to which attendance and use of online lecture resources (Outline and Complete Notes) were related to examination performance. For these analyses, the data were centred values of note use and attendance associated with the lecture days for which attendance could be directly determined and the examination items

Table 2. Analysis of variance for complete note access.

Source	d.f.	*F*	Partial Eta squared
Group (G)	1	0.355	0.00
Error (G)	210	(0.01)	
Examination (E)	2	24.33*	0.10
G × E	2	0.43	0.00
Error (E)	420	(0.029)	
First Access (FA)	1	8.35*	0.04
G × FA	1	1.98	0.01
Error (FA)	210	(0.087)	
E × FA	2	15.33*	0.07
G × E × FA	2	1.34	0.01
Error (E × FA)	420	(0.038)	

Note: Significant outcomes marked with an asterisk (*). Values in parentheses represent mean square errors.

Table 3. Regression analyses predicting performance on lecture items from note use and attendance.

Variable	*b*	β	*t*	sr^2
First examination				
Attendance	0.262	0.156	2.97*	0.02
Note use	0.189	0.108	2.07*	0.01
Interaction	–0.204	–0.078	–1.51	0.01
Second examination				
Attendance	0.290	0.225	4.23*	0.05
Note use	0.167	0.108	2.02*	0.01
Interaction	–0.214	–0.110	–2.07*	0.01
Third examination				
Attendance	0.107	0.095	1.73	0.01
Note use	0.128	0.076	1.37	0.01
Interaction	–0.189	–0.099	–1.81	0.01

Note: Significant outcomes marked with an asterisk (*).

associated with these lectures (five items on each examination). The results of these analyses are summarized in Table 3 .

For the first and second examinations, attendance ($\beta = 0.16$ and $\beta = 0.23$) and use of online resources ($\beta = 0.11$ and $\beta = 0.11$) were significantly related to performance on lecture examination items. For the second examination, the interaction of attendance and note use was also related to examination performance ($\beta = –0.11$). The nature of this interaction is explored in Fig 2. This figure displays regression lines based on values of note use that are one standard deviation below and above the mean. For this examination, the interaction results from the more positive performance of those were less likely to attend class and more likely to access online notes.

Discussion

Course management systems offer instructors powerful tools that can be applied in a variety of ways. Presently, one of the most common uses of such systems by campus-based instructors is to offer students lecture supplements (Morgan 2003). The present research summarizes descriptive data on student use of one category of lecture supplement. This category consisted of what might be described as alternative representations of lecture content; lecture outlines, lecture summaries and recorded lectures. Collectively, these resources are not intended to offer additional information, but represent the lecture information in ways that may meet a wide range of student needs.

One of the most basic questions in this context is whether students will make voluntary use of resources provided to them. The most surprising outcome in this research was the low rate at which students used the recorded lectures. As a comparison, students viewed 61% of lecture outlines, but listened to only 3% of the online audio files. The rate of audio use was so low and so many students accessed no audio files that it was not practical to perform additional analyses with this category of data.

The data on use of the audio content would seem a sobering contradiction to what seems to be growing interest in offering supplemental audio content to students (e.g. pod-casting). There are several possible explanations for what was observed here. Perhaps access, technical requirements, and social obstacles have been underestimated. Access to personal computers and perhaps portable audio players may be lower than some assume. Bringing earphones to open access labs may not represent a reasonable alternative for students not owning personal devices. We favour a different type of explanation. In this research, students had access to two complete representations of each lecture; an audio file, complete notes. We speculate that complete notes may simply have provided students the more efficient alternative. Students can review complete notes far more quickly than they can listen to the corresponding lecture. Locating detailed information within a written summary may be easier than finding the same section of material within an audio representation. The information provided in complete notes has also been generated by an individual with more content expertise than the students viewing the notes. In

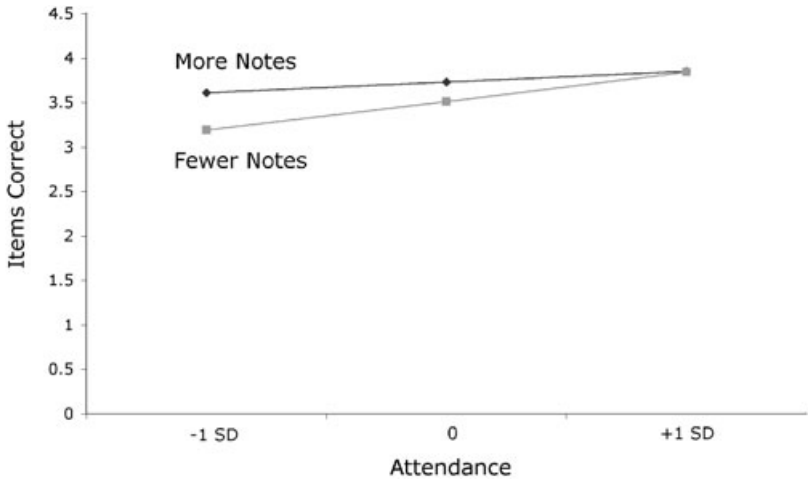

Fig 2 Regression lines summarizing note use by attendance interaction for second examination.

contrast, the audio representation of a lecture is unprocessed information. Perhaps students simply regard written lecture summaries as more useful or efficient. If these findings are representative, the logic supporting the increasing emphasis on supplemental audio content should be carefully examined in future research. While audio files are very easy to generate using a personal computer and very easy to distribute using a CMS, paying a graduate student or even a high achiever within the class to generate a set of notes for distribution may be a more popular and possibly useful service.

A second focus of this study was the relationship between student attendance and the use of online lecture resources. Some have speculated (e.g. Potts 1993; Weatherly *et al*. 2003) that access to online lecture resources, particularly resources that provide a complete account of the lecture, results in lower rates of class attendance. Past attempts to establish a relationship between attendance and use of online lecture resources have not demonstrated a negative relationship between attendance and resource use (Grabe *et al*. 2004–2005; Grabe & Christopherson 2005; Vandehey *et al*. 2005).

There is little evidence here that note availability encourages absenteeism. The data indicated that those who attended class more frequently systematically made greater use of online lecture resources. The one finding that demonstrates a possible compensatory use of online resources by the students prone to skip class is present in the interaction of attendance group and first access. There are large group differences in viewing outline notes before the lectures, but not after the lectures. When participants assigned to the low attendance group did use outline notes, the notes were proportionally more likely accessed when less theoretically valuable, but when the notes may have served the purpose of compensating for the lack of attendance. Two factors argue against this interpretation. First, the interaction is probably an artifact of the coding of note use according to the date of initial access. Again, this was done because after the first viewing many students used printed versions of the notes-making data on multiple online accesses uninterpretable across participants. By viewing a high proportion of notes before lectures, the high attendance group reduced the opportunity to view notes for the first time after the lectures. In a way, the interaction with attendance group may result from the much greater commitment of the high attendance group to use the notes rather than a difference in strategy. Second, it would seem logical that if note use was intended to serve the primary purpose of substituting for class attendance, it would make sense to use the complete rather than the outline notes. The complete notes provide a better record of all that was presented during each lecture. The high attendance group also made greater use of the complete notes.

This study demonstrated a positive relationship between online note use and examination performance. Given the method used in this research, a causal relationship between more frequent use of the online resources and course performance cannot be established. We would argue that controlled laboratory studies are suited to evaluating causal relationships and that such studies have demonstrated that in certain circumstances

providing notes improves performance. Studies in naturalistic settings are necessary to determine how students adjust the potential of a proven learning resource to personal motives and needs. Greater use of online resources was associated with higher examination scores for the first and second examinations. The most interesting finding in the analyses of the relationships among achievement, attendance, and note use was the significant interaction observed for the second examination. For this examination, it appears that greater use of online lecture resources compensated for lower attendance resulting in higher examination scores. While the inability to demonstrate this interaction consistently is problematic, the finding is intriguing. The small number of examination items on a given examination that could be linked to objective attendance data may have been the cause of measurement problems. Attendance data such as that used by Vandehey *et al*. (2005) is cumbersome to collect in large classes, but future efforts to accurately measure attendance over multiple class periods and relate attendance, online resource use, and more reliable measures of lecture-related performance may be productive. Factors, such as motivation variables, potentially moderating the relationship between attendance, use of online resources, and examination performance may also be productive to study. It seems possible that differences in student motivation may explain a great deal. More motivated students would probably be less likely to miss class, but more likely to take advantage of available resources when class attendance was not possible. Even the source of motivation may be associated with differences in student behaviour. In circumstances where the content focus and type of examination items allow, students focused mostly on higher examination scores may find that access to quality notes is as efficient as class attendance in meeting personal goals. In contrast, when class time is focused more on the exploration of ideas, when examinations are developed to evaluate a deeper understanding of core ideas, and when learners are motivated by their interest in the content as well as by performance, online resources may represent a way to follow-up on rather than substitute for class experiences. Large sample sizes will be necessary for the statistical procedures necessary to identify patterns among these variables.

We present our data concerning student use of multiple lecture representations as descriptive and admit that these data are mostly useful in raising questions and challenging assumptions regarding what students will value. Future studies might productively combine quantitative data that establish patterns of student behaviour with interviews or questionnaire items allowing students to explain their motives and strategies.

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